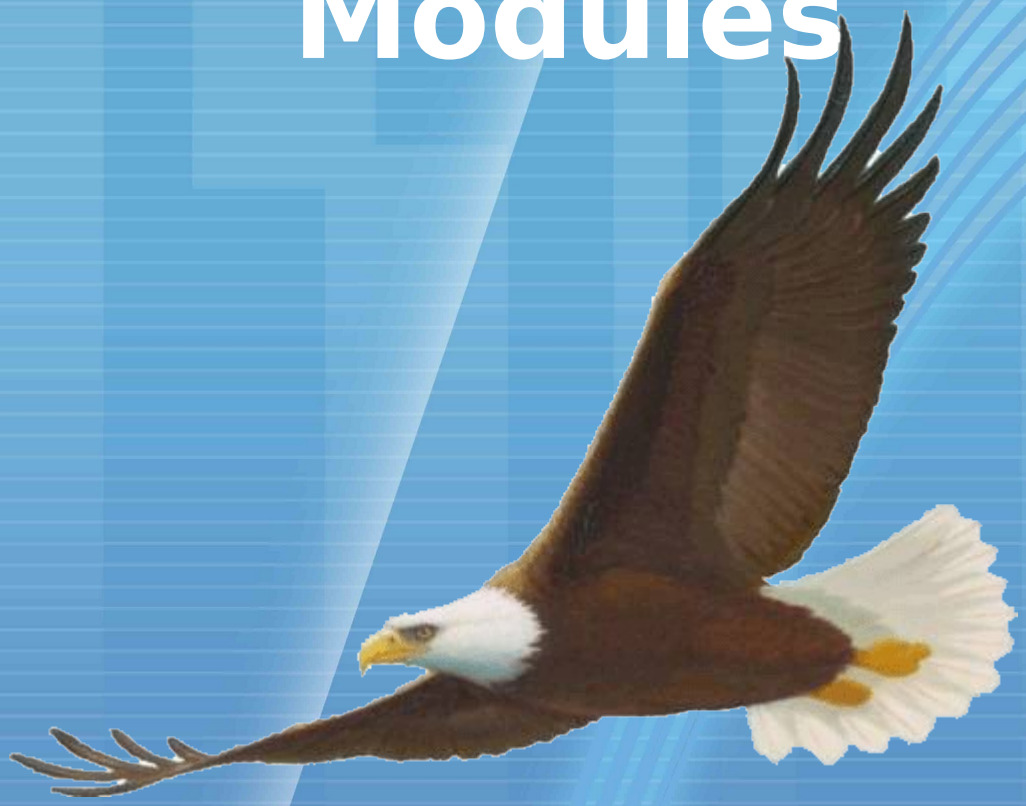
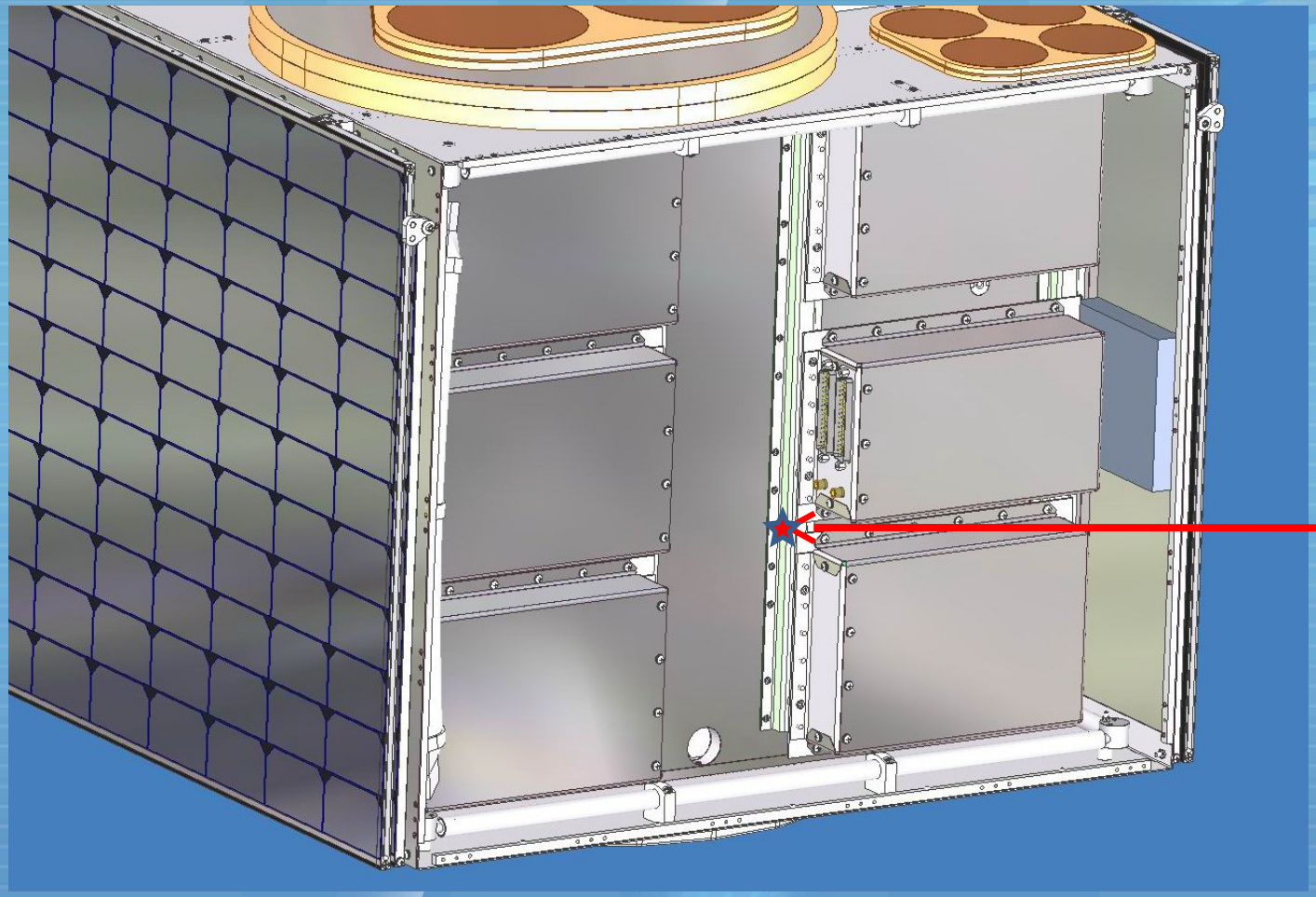
Thermal Design of Eagle Modules



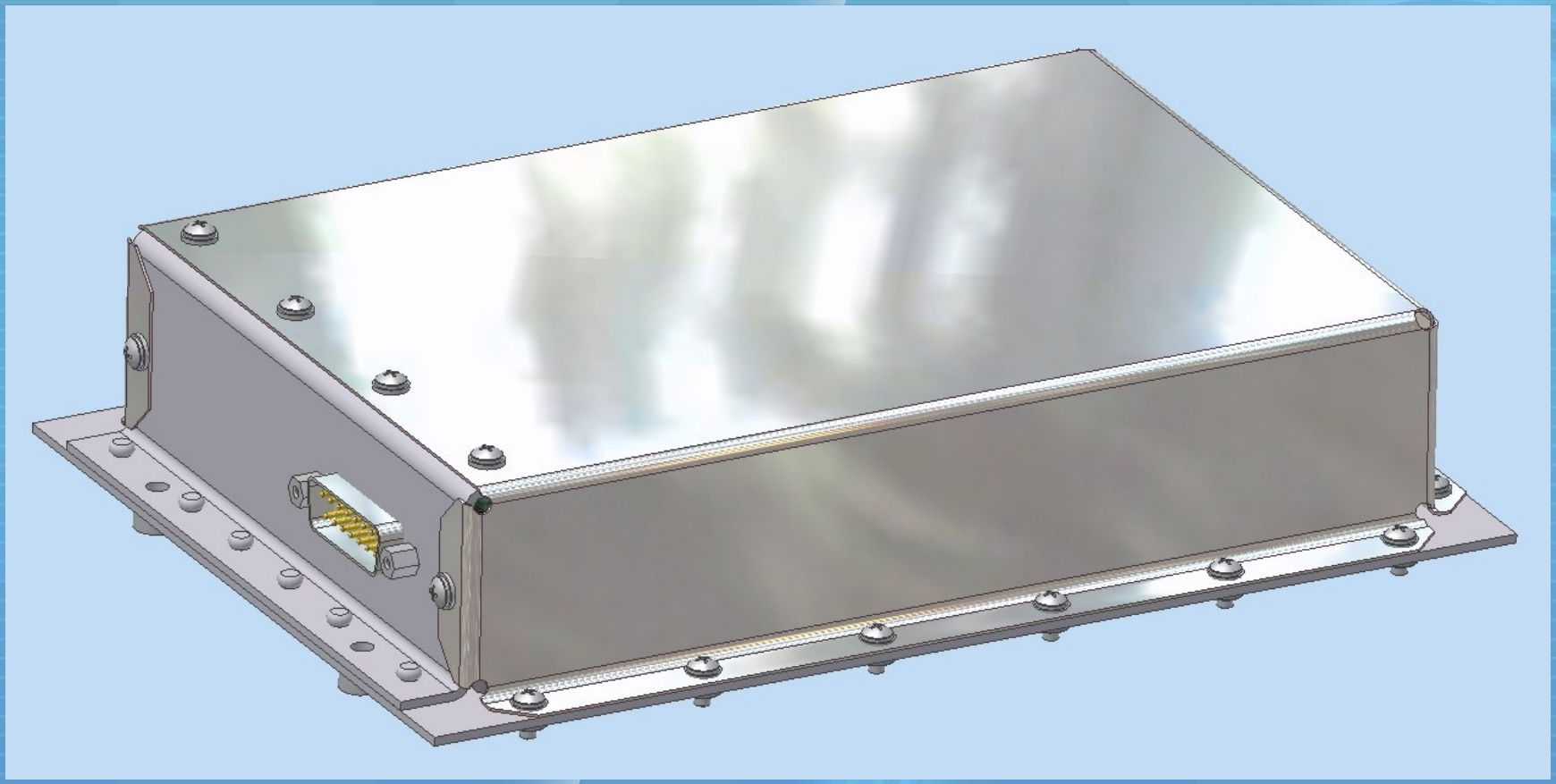
Module Bay of Eagle

(early design)

Eagle (new) Module Bay Will be Similar Size



Eagle E05 20 Module

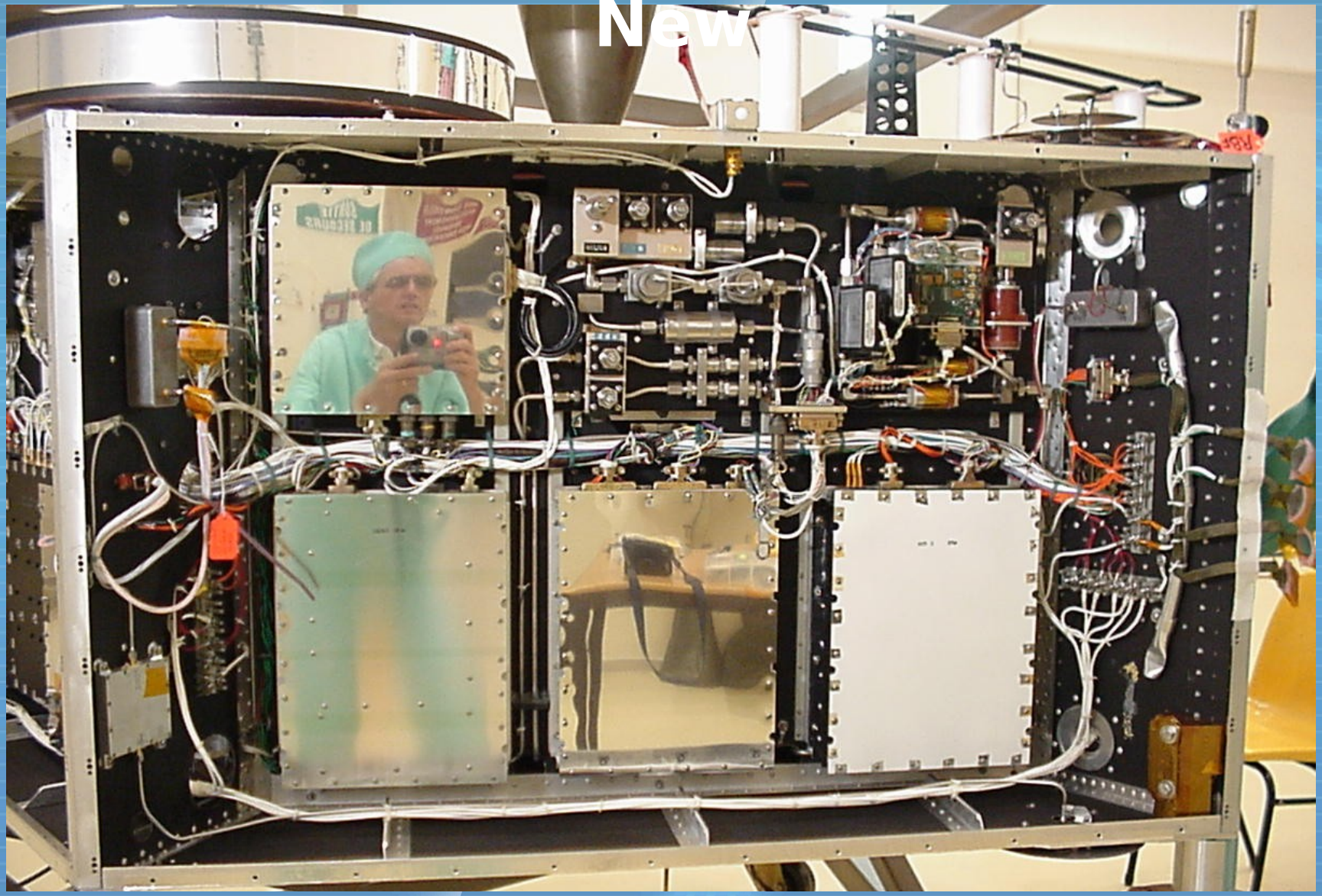


Mean Emittance vs. Allowable Power Dissipation

Module: +20°C, Spaceframe: 0°C

Mean Emittance	Allowable Power Dissipation
0.04	0.4 W
0.15	1.3 W
0.4	3.9W
0.91	7.9 W

Module Thermal Coatings Are Not New



Power Densities

Solar Heating in Space = 135.4mW/cm²

Solar Heating on Earth ≈ 94.8mW/cm²

Or considerably less

Power Density of URx Power Section

≈207mW/cm²

U Receiver PCB Top Layer

Showing Component Areas of Thermal Concern

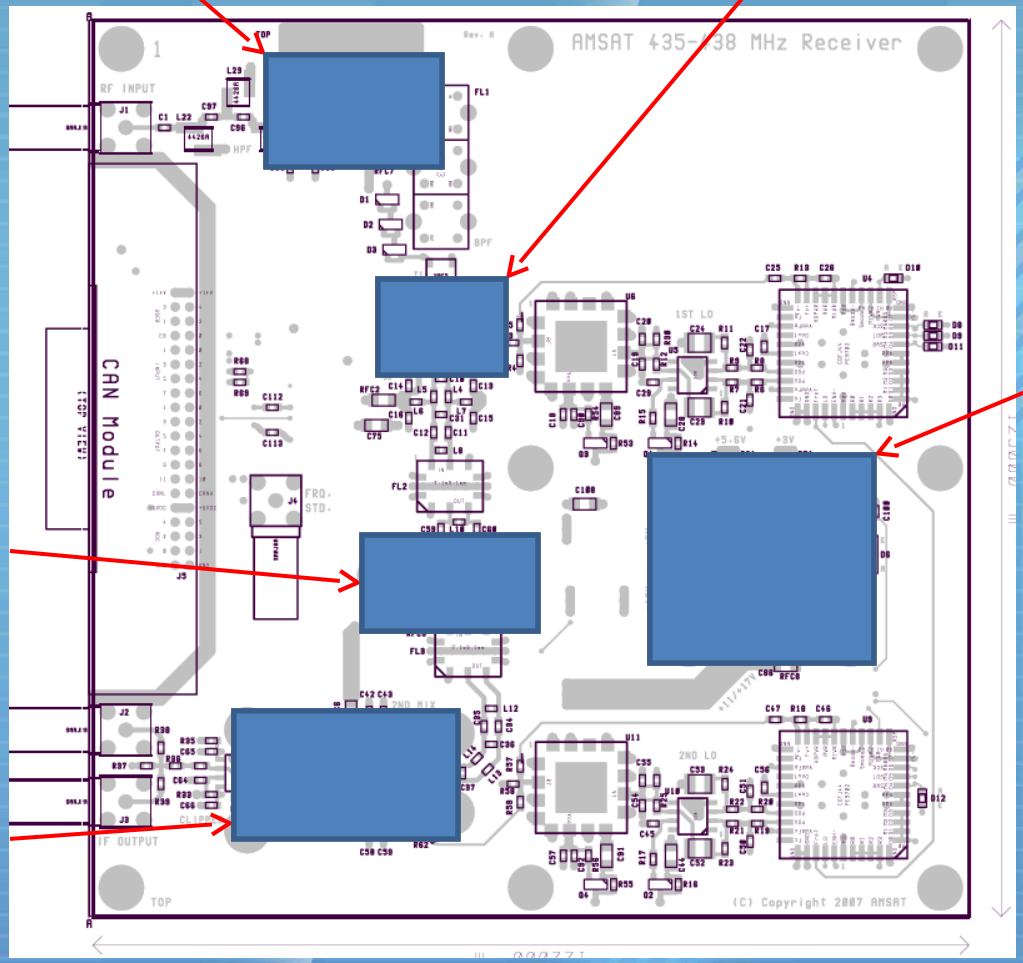
RF Amp. 450mW

1st Mixer 280mW

Power Supplies, etc., 1284mW

IF Amp. 300mW

2nd Mix., Output Amp. 670mW



U Receiver PCB Bottom Layer

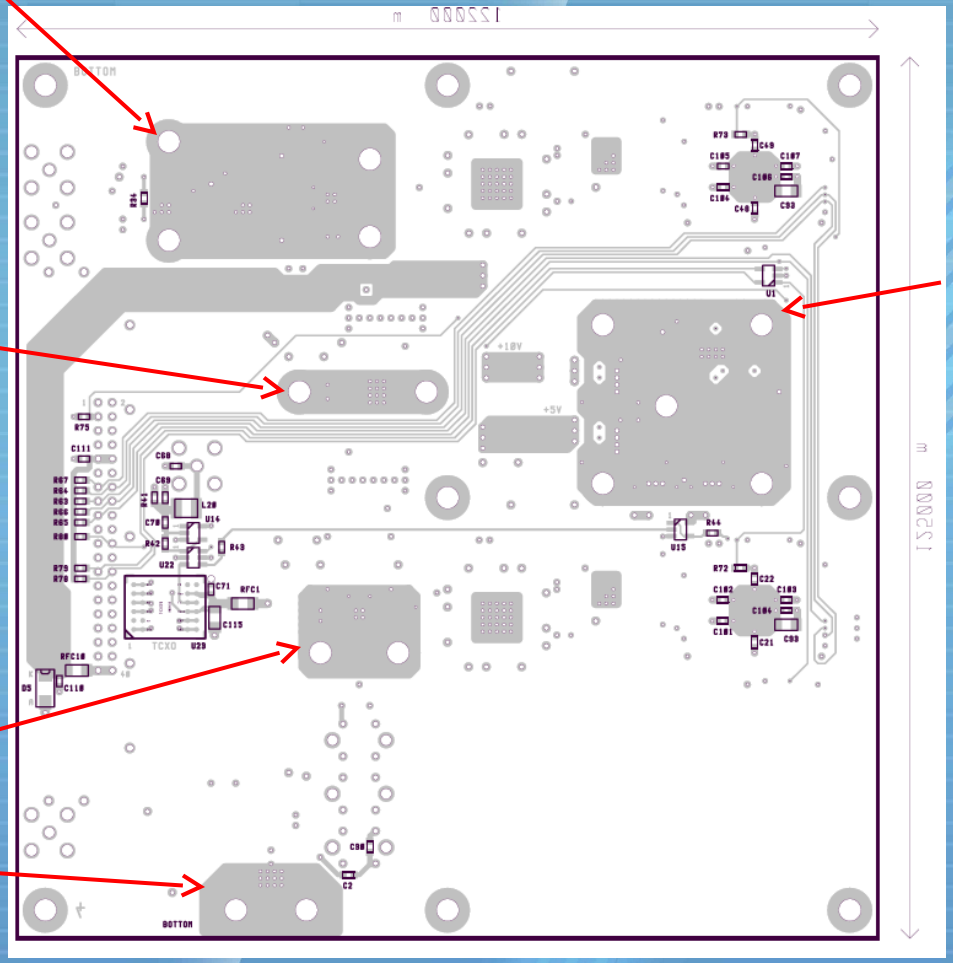
Showing Heat Sink Pads

2nd Mixer & Output Amp Pad

IF Amp. Pad

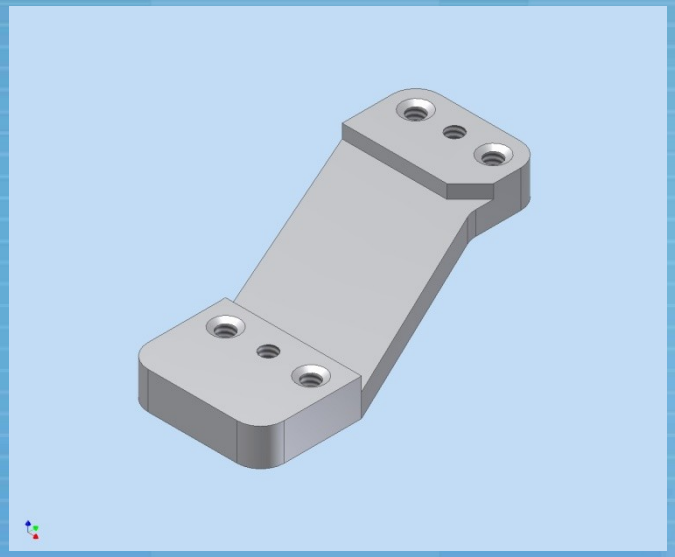
1st Mixer Pad

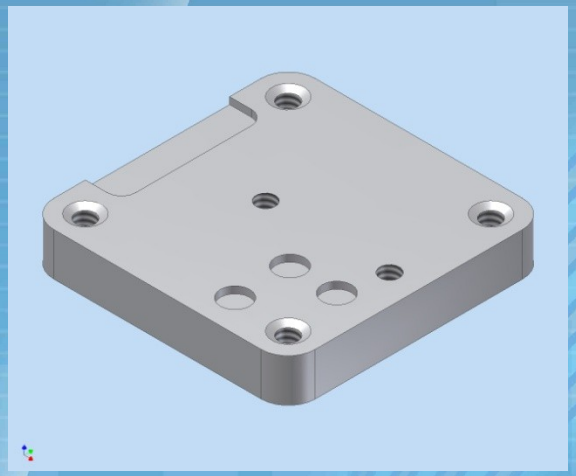
RF Amplifier Pad

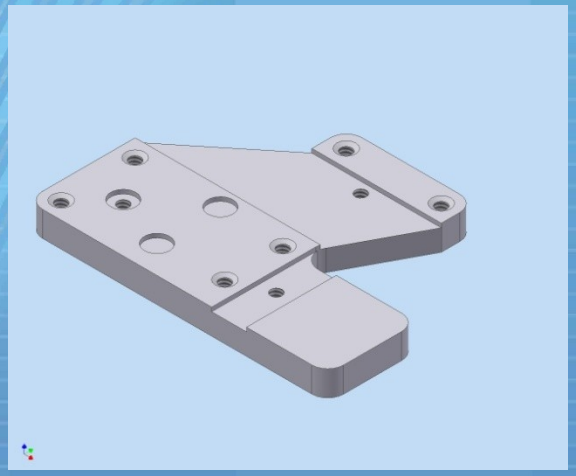


Power Supply Pad

U Receiver Special PCB Heat Sinks

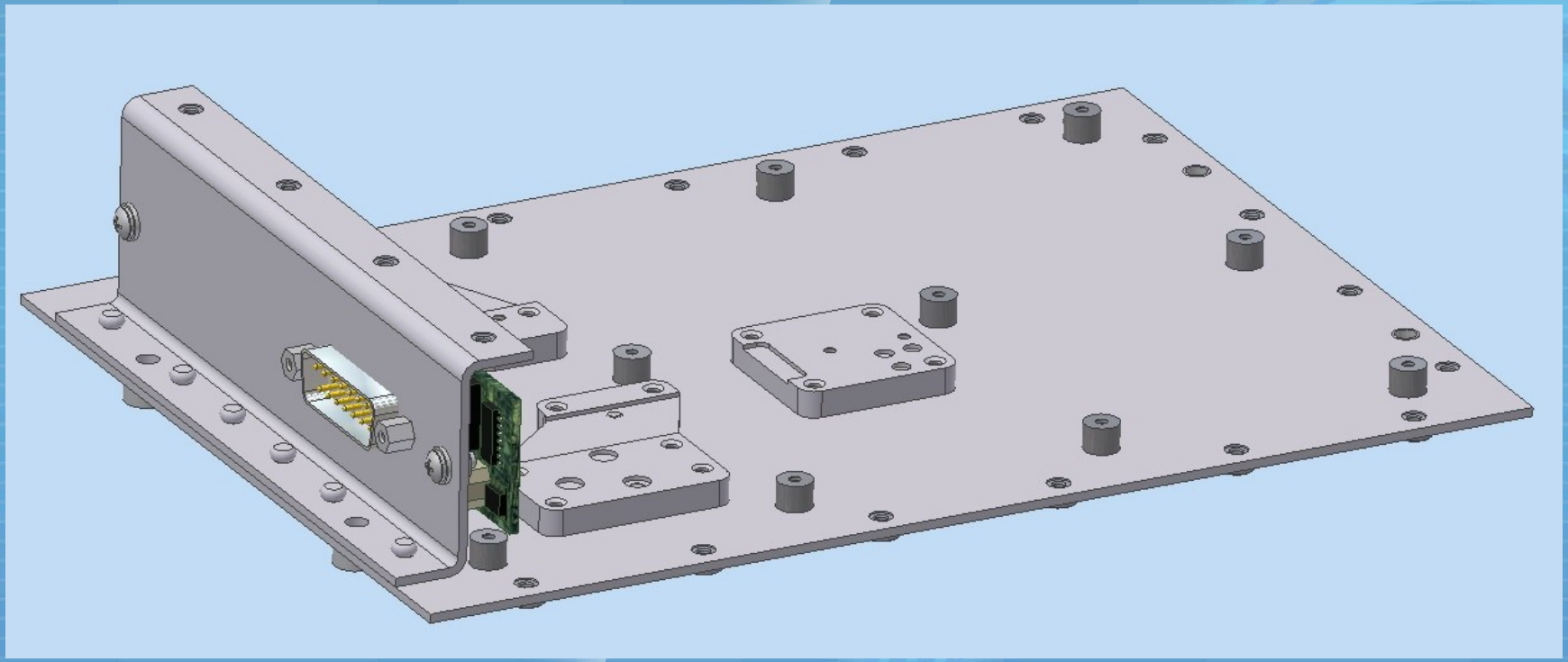






U Band Receiver

E05 20 Module Baseplate With Heat Sinks Mounted



Eclipse Temperatures

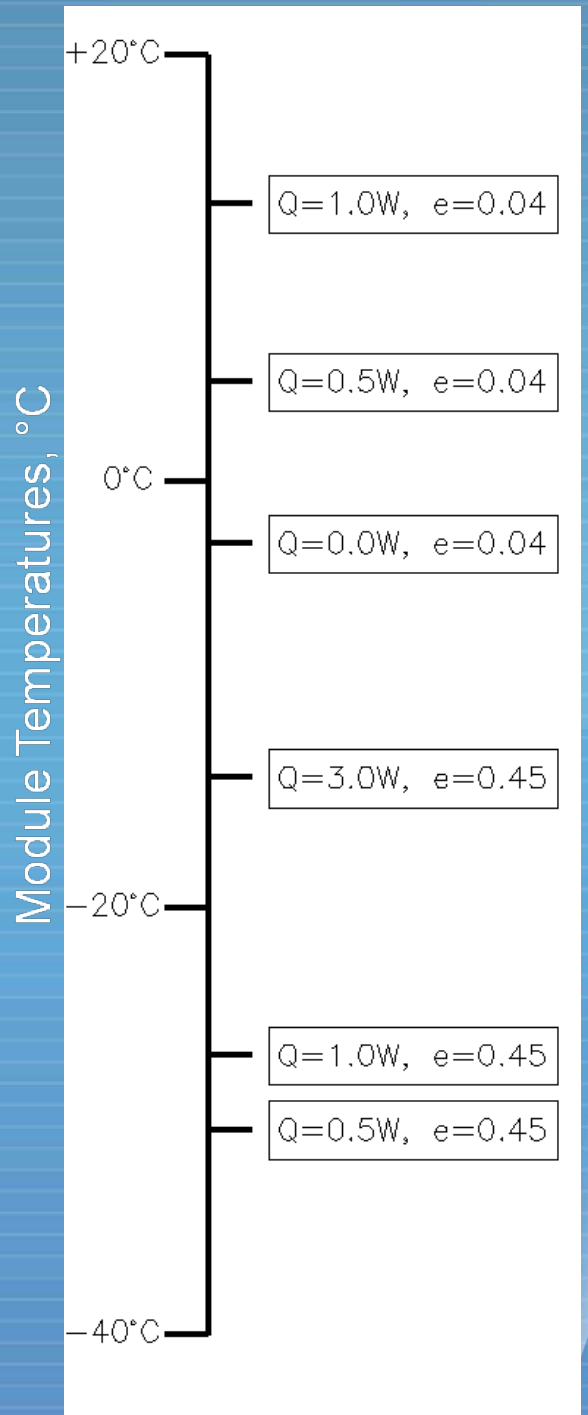
- **Eclipse temperatures of AMSAT HEO spacecraft have been of a concern for more than 25 years.**
- **Early P3 spaceframes were known to be quite cold in eclipse, as seen in AO-10 telemetry, (not currently available).**
- **Small Eagle thermal analysis shows, in 3 hours of cooling:**

Spaceframe: -26/-45°C

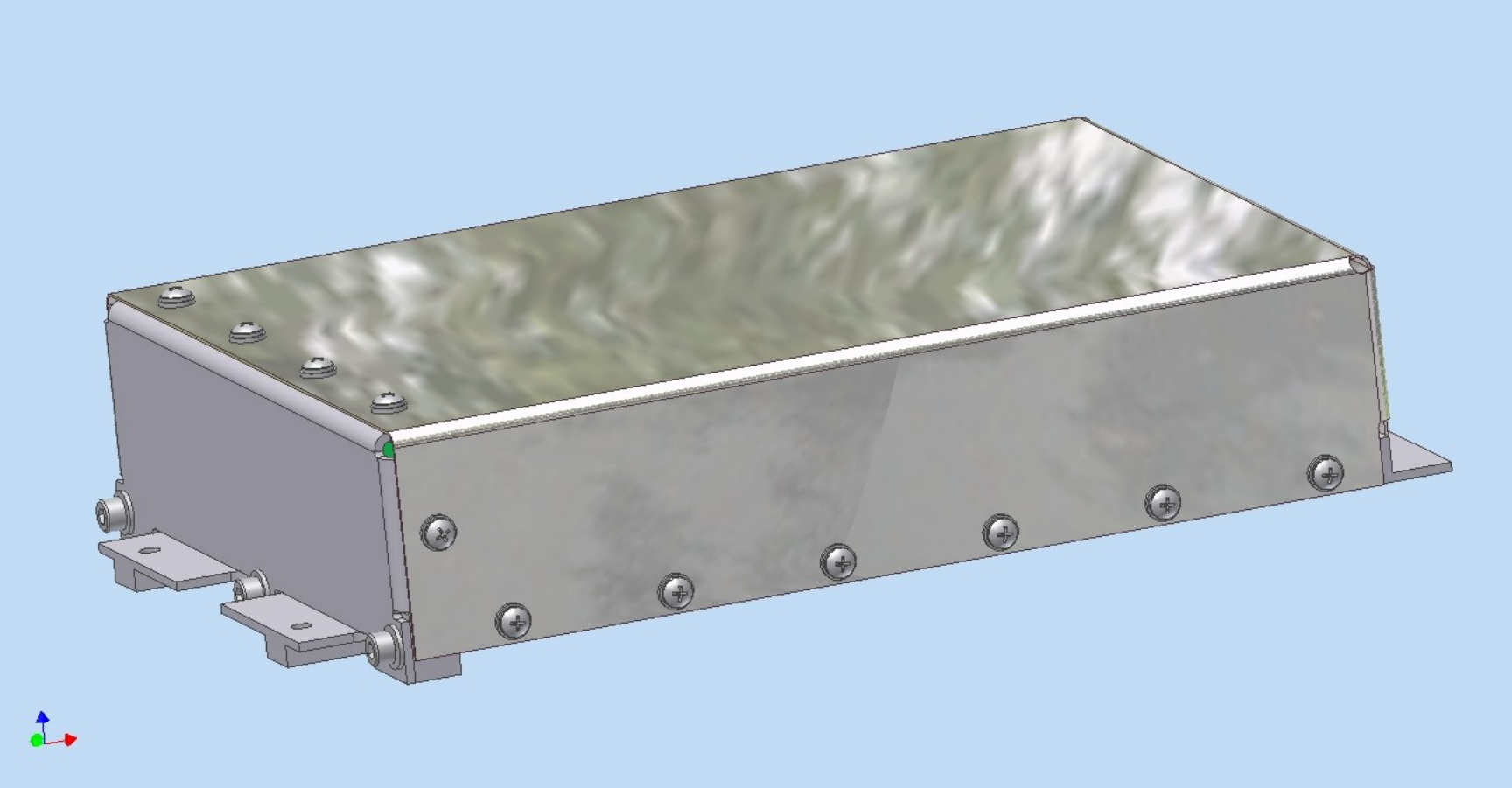
Solar Panels: -81/-125°C

Eagle Module 3 Hour Eclipse Temperatures

Showing effects of module emittance and power dissipation



A New Module, the E05 60, 140x180 PCB



PCB Thermal Analysis Model